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Report of the PSARC Invertebrate Subcommittee Meeting January 26, and 28-30, 1998 and the Steering Committee Meeting February 18, 1998

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I. STEERING COMMITTEE REPORT

PSARC Steering Committee met 18 February, 1998 at the Pacific Biological Station, to review the Invertebrate Subcommittee report. The Subcommittee report was accepted by the Steering Committee. Steering Committee provided the following comments pertaining to general Subcommittee concerns, to individual Working Papers, and Fishery Updates summarized in the Subcommittee Report.

Steering Committee Discussion on General Subcommittee Concerns

(i) Request for Working Papers

Steering Committee endorses the formal Request for Working Papers adopted by the Subcommittee, and suggests that this approach be considered by other subcommittees and reviewed at the Subcommittee level.

Steering Committee also notes that requests for working papers from external sources have implications that need to be handled in a similar manner. PSARC needs to put a process in place to deal with external requests for working papers.

(ii) Corporate Databases

Steering Committee notes that database issues are a frequent concern raised at Subcommittee meetings. These database issues need to be evaluated and resolved since they have an impact on DFO's ability to conduct assessments. Specific direction needs to be given to FMIS Steering Committee to integrate and reconcile corporate databases needed for management and assessment. Steering Committee understands that progress can only be made if the necessary resources are allocated to address these database issues.

More information is required on the levels of illegal harvest of abalone in British Columbia. Steering Committee recommends coordination of efforts among StAD, Fisheries Management and C&P to attempt estimating the level of illegal catch.

(iii) Catch Reporting Compliance

Steering Committee recommends that the Shellfish Working Group develop measures to deal with the persistent non-reporting of catches in some invertebrate fisheries.

(iv) PICES Process

Steering Committee notes that any request for information from PICES should be directed through the Regional Director of Science.

Steering Committee Discussion on Working Papers and Fisheries Updates

The Steering Committee reviewed the Invertebrate Subcommittee report dealing with nine Working Papers and four Fishery Updates.

Working Papers I98-2 and I98-3: Phase 0 Assessments

I98-2 Fisheries Biology of the Giant Pacific Octopus

Steering Committee endorses the Subcommittee recommendations and notes that development of any new fisheries should be guided by the draft Policy for New and Developing Fisheries. Steering Committee further recommends that caution be exercised when expanding an existing fishery. Steering Committee reiterates its comments with respect to data limited fisheries and that without additional data PSARC cannot determine whether the octopus fishery can sustain anticipated growth or further development. Steering Committee suggests that the imposition of license limitation and biologically based management are both necessary and suitably precautionary for this fishery.

I98-3 A Review of the Biology and Fisheries of Horse Clams

Steering Committee notes that there is potential for directed horse clam fisheries but that there may be potential demands for additional allocations from user groups. Steering Committee supports the development of horse clam fisheries and recommends that the development follows Phase 1 of the *Framework for Providing Scientific Advice for the Management of New and Developing Invertebrate Fisheries* (I96-6). The development should also follow the guidelines of the draft Policy for New and Developing Fisheries.

The Steering Committee concurs with the Subcommittee recommendation that harvesting activities for Horse Clams should not occur in or near eelgrass beds, and that a habitat assessment to determine sensitive areas should be carried out.

I98-4 Survey of the Northern Abalone, in the Central Coast of British Columbia, May 1997

Steering Committee endorses the Subcommittee recommendations. Steering Committee reiterates the Subcommittee concern that continuing declines in abalone stocks are cause for alarm. Steering Committee agrees that further surveys are necessary to maintain the time series of data, but notes that no progress has been made to develop a comprehensive recovery plan for abalone.

I98-8 Catch Composition of British Columbia Shrimp Trawls and Preliminary Estimation of Bycatch - with Emphasis on Eulachons.

Steering Committee notes that the bycatch of eulachon is a concern but that no assessment framework for eulachon is in place. Steering Committee recognizes that there is a need for more assessment work and that the consequences of this bycatch should be evaluated. DFO should proceed cautiously because the magnitude of the eulachon bycatch in the shrimp trawl fishery is potentially significant. However, Steering Committee recognizes that the stock size of eulachons is unknown.

Steering Committee strongly endorses Subcommittee recommendation 4: "DFO should work with and encourage industry to adopt technological and management measures to reduce bycatch; this should not be delayed."

I98-9 Status of Harbor Seals

Steering Committee accepts the Subcommittee recommendations from this working paper.

I98-1 Assessment of the Area A Crab Fishery in British Columbia.

The Steering Committee accepts the recommendations of the Subcommittee from this working paper. Steering Committee notes that the dynamics of this fishery have

changed significantly and that adopting the recommendations will improve the management of this fishery. Steering Committee is particularly concerned about the increasing length of soak times for crab traps which is occurring. These longer soak times may result in substantial mortality of crabs and are an unacceptable practice which needs to be eliminated.

Crab Papers: I98-5, I98-6, I98-7

These working papers have been published in the primary literature. The Subcommittee has reviewed the Working Papers for the purposes of their applicability to B.C. fisheries assessment and management.

Steering Committee acknowledges the Subcommittee conclusions for the three crab papers. Steering Committee notes that Green Crab are now reported from Coos Bay, Oregon and that a sampling program may need to be started in B.C.

Fishery Updates

Steering Committee concurs with the Subcommittee comments.

II. INVERTEBRATE SUBCOMMITTEE REPORT

1. Introduction

The Subcommittee met in Nanaimo at the Coast Bastion Hotel January 26, and 28-30, 1998. The Subcommittee reviewed nine Working Papers and four Fishery Updates. The Subcommittee discussed four issues of general concern to the assessment and management of invertebrate resources in the Pacific Region.

2. General Subcommittee Issues and Recommendations

Request for Working Papers

The Subcommittee reviewed the trial process for requesting working papers initiated for the January 1998 meeting. A formal *Request for Working Paper* (Appendix 7) was prepared by a Fisheries Management manager with objectives being jointly developed by the author(s) and the manager. The purpose of the request is to allow a clear understanding of the purpose of the working paper and to facilitate prioritization. The Subcommittee was pleased with the process and **recommends** that it be adopted for all subsequent meetings. Request forms are to be submitted to the Shellfish Coordinator for 1998 and 1999 (as available) working papers. Requests from industry are to be directed through the appropriate manager.

It was noted that the long-term goal for Shellfish Stock Assessment is to develop an assessment framework for each species.

Corporate Databases

The Subcommittee notes that changes have been made in the collection of fishery information, particularly with the introduction of third party dockside and catch monitoring programs. This has caused a problem with consistency and compatibility of the existing corporate databases, i.e. fishslip database. At this time there is no central source to obtain catch statistics for all invertebrate fisheries.

The Subcommittee is also concerned that access to some databases is not practicable, in particular C&P data. This is a particular problem in trying to assess the extent of illegal harvest of abalone that has been documented. The Subcommittee **notes with concern** the great need for integration and reconciliation of all corporate databases.

Catch Reporting Compliance

The Subcommittee **highlights** the persistent non-compliance with the catch reporting condition in some invertebrate fisheries. Papers I98-1 and I98-2 as well as several fishery updates, bring to the attention of the Subcommittee inadequacies in regard to misreporting of areas, catch and effort. The Subcommittee notes that, in some fisheries, data quality and compliance has improved with the implementation of dockside monitoring.

PICES Process

The Subcommittee notes that the development of the Phase 0 working papers for octopus and horseclams would have been greatly supported by better access and communication with agencies from other jurisdictions (Japan) regarding the catch and management actions. In addition, as DFO moves into new fisheries, a forum for obtaining the best possible information on assessment and management issues would be highly beneficial.

The **Subcommittee recommends** that a request be made to PICES to determine how information, particularly for cephalopods, might be generated though PICES activities. Subcommittee notes that continued participation in the PICES Crab and Shrimp Working Group will support Pacific Region assessment and management.

3. Working Paper Summaries, Reviews and Discussion

I98-1 Assessment of the Area A Crab (*Cancer magister*) Fishery in British Columbia. J. A. Boutillier, T. H. Butler, J. Bond, I. Winther and A. Phillips.
Accepted subject to major revisions

Summary

This paper is an assessment of the crab (*Cancer magister*) populations for British Columbia Crab Fishing Area A and adjacent offshore areas in Hecate Strait. Three types of analyses were conducted: (1) a review of the various fishery dependent abundance indices and biological data; (2) biomass dynamic modelling of the various abundance indices; and (3) a yield per recruits analysis of the theoretical growth, natural mortality and value data. There were a number of findings indicated that were quite different trends depending on the abundance index used and that care must be taken to determine the most appropriate index. In general, however, there were some findings that were consistent throughout. These included:

- that the fisheries in "McIntyre Bay" and "Hecate Strait" have quite different dynamic behaviour.
- that present effort levels are higher than E_{opt} in both the biomass dynamic models and the yield per recruit models.

As a result of the various findings, the following recommendations were made:

- improve the logbook data and fish slip data. This will include consulting with Industry to determine ways of improving reporting;
- manage McIntyre Bay and Hecate Strait as separate stocks. Be aware that the McIntyre Bay populations do not go through the same fluctuations and seem to be a much more stable fishery. Also be aware that most of the analyses indicate that effort in the area already exceeds E_{opt} and with the decline in abundance indices experienced in Hecate Strait, there may be a shift into McIntyre Bay from boats that do not have other options;
- there is a need to develop a fishery independent assessment program that will provide checks as to the most appropriate fishery independent index;
- there is a need to collect biological data from fishery dependent and independent sources that are more consistent in frequency, cover critical biological periods (minimum spring and fall i.e. pre and post moulting), and are more detailed with respect to the biological information gathered. Also, objective shell condition criteria must be developed;
- Industry should be discouraged from leaving gear to soak for excessive periods of time, as the impact in terms of mortality of crabs is probably significant.

Reviewers' Comments

Reviewer 1 noted that the paper contained some good analyses and information. The data, the discrepancies by area, as well as the possibility of misreported catch between Areas 1 and 2 should be more thoroughly discussed. The Hillborn and Walters 1992 system of terminology should be more clearly defined. He questioned the relevance of the section that discusses 'original state' and suggested that further description is required. He suggested that the use of equilibrium models in this application was limited and that both the usefulness and potential problems of this approach be discussed in

the paper. The reviewer suggested that the description of the yield per recruit analysis should be expanded. The difference factor may be a measure of stability but should not be used as a measure of the ability of the CPUE to track stock abundance. In addition, the correlation between the four indices should be examined. The relevance of the use of Breen's soak time mortality data should be further explained. The conclusions of the paper stating that the conservation goals are not being met nor are optimal returns being realized with the current management regime, are not supported well enough to be accepted.

Although Reviewer 2 acknowledged that the paper represents a considerable body of work on this important resource and is a good first look at the data, he did not feel that the analyses presented support the original questions posed nor several of the recommendations. It is not clear if the noted increase in catch and effort are a result of an increase in abundance. Conservation goals should be defined near the beginning of the paper. The modelling presented represents significant work; however, the reviewer questioned the use of the short time series of data for the equilibrium analyses. The conclusion that harvest is occurring above E_{opt} is not clearly supported in the paper. The analyses to examine optimal return was difficult to follow and not well presented for managers to base a decision on. The rationale for some of the recommendations was not sufficiently developed in the paper. Problems with current logbook data need more detailed description as the basis for a recommendation of the paper. The rationale for splitting the management of licence Area A was not clearly developed.

Both reviewers made a number of editorial and organizational comments, suggested a number of instances where the terminology used could be standardized and requested a clear statement of the objectives of the paper.

Subcommittee Discussion

The recent pulse in recruitment has resulted in high catches and has encouraged over-capitalization and expansion in the fleet. There are concerns that the apparent decline in catch in Hecate Strait will cause an increase in fishing pressure in the adjacent McIntyre Bay. The Subcommittee discussed the appropriateness of the current management given the large increase in fishing capacity, however no conclusions can be made regarding whether current effort is above E_{opt}, based on the analysis presented. The Subcommittee notes that the recent high levels of abundance of Hecate Strait crab stocks may not be sustained, given the apparent large fluctuations in recruitment.

The Subcommittee was pleased with the work as a good first step, in spite of the fact that the questions posed in the beginning of the paper cannot yet be answered. There was significant discussion around the retooling of the paper to illustrate why the questions posed cannot yet be answered. However, the Subcommittee felt that the paper should go forward because it contained a significant body of work and some important recommendations.

The Subcommittee notes that the major limitation in answering the questions posed, appear to be the inadequacies in the fishery and biological data. Of particular concern is the inability to distinguish between cohorts and the lack of information on juveniles and females.

The Subcommittee observes that the paper did show that soak time is increasing and in many cases exceeds the current 14-day regulation. Data presented on the mortality associated with long soak times indicates that there could be significant loss in production.

Subcommittee Recommendations

The Subcommittee accepts the paper subject to major revisions that include the editorial comments of the reviewers and rearrangement of the contents, as well as rewording of the recommendations to better reflect the conclusions that can be made from the analysis.

1. The Subcommittee supports the recommendation in the paper that logbook and fish slip reporting requirements be improved. The Subcommittee notes that this may involve an evaluation of the logbook format and working with fishers.

2. The Subcommittee recommends that more detailed biological fishery and fishery independent data are necessary. Sampling should cover critical biological periods through the year. The development of objective shell condition criteria is also required.
3. Managers should be aware that mortality associated with long trap soak periods increases with time and soak periods in excess of the current 14-day regulation are increasing in this fishery.

I98-2 Fisheries biology of the giant Pacific octopus, (*Octopus Dofleini)* (Wulker, 1910), with a discussion of octopus fisheries in British Columbia. G.E. Gillespie, G. Parker and J. Morrison. **Accepted subject to revisions**

Summary

This was requested because of concerns regarding recent trends in catch and effort and industry information on the British Columbia octopus fishery. Managers are concerned that the number of participants, total effort, and catch are increasing. Industry information indicates that potential food markets are developing, and that the landed price for octopus is increasing. There is continued interest in the development of a directed pot fishery for octopus. We are also concerned that the present assessment and management framework for octopus fisheries in British Columbia, which applies to a low-value bait market fishery, may not be appropriate for a high-demand, high-value food market fishery.

This Paper completes the following:

1. A literature search to gather and synthesize all available information on the biology, behaviour and ecology of *Octopus dofleini*;
2. Critically reviews available information on British Columbia octopus fisheries;
3. Reviews fisheries for *Octopus dofleini* and major fisheries for other octopods elsewhere in the world;
4. Discusses current octopus fishery issues; and
5. Provides advice to senior managers for the rational management of the directed dive fishery, bycatch fisheries and developing pot fisheries for *Octopus dofleini* in British Columbia.

There is a need to better understand octopus population structures and dynamics and how fisheries affect them. Without estimates or indices of abundance and a better understanding of which portions of the octopus populations are vulnerable to specific fisheries, rational allocation between gear types is not possible. Precautionary actions to prevent sudden, significant increases in participation, effort and landing in the octopus fishery until information is available to develop assessment and management frameworks for octopus fisheries, are recommended. Efforts must be directed at collecting better data on catch, effort, biological information and improving the data systems.

Reviewers' Comments

Reviewer 1 suggested that a brief discussion of western Alaska octopus fisheries and capture methods should be included in the working paper, since it yields the bulk of the Alaska landings, but cautioned that there are likely some significant problems in Alaskan landing statistics. The issue of multiple versus single matings for males can be significant to a management program and the reviewer suggested that research projects that further the understanding of the reproductive process be undertaken. For future stock assessment work, the reviewer suggested that the species would be a good candidate for mark-recapture studies and habitat-based assessments. Finally, it was suggested that the establishment of refuge areas would be useful for improving the understanding of octopus biology, recruitment and distribution.

Reviewer 2 commented that more information should be included on why some current worldwide octopus fisheries are considered over-fished and whether there was any information on those fisheries that could help managers avoid a similar occurrence in B.C. The reviewer disagreed with the authors' statement that it is premature to discuss management tools and stated that the resource needs to be conservatively managed now, and that effort be concentrated on ensuring that all removals are documented.

The initiation of an octopus stock assessment program was highly recommended. This could include the use of (improved) logbook data, historic catch, CPUE and average weight to determine density characteristics of specific habitats, and the combination of historic production with estimates of area fished and available habitat to produce estimates of biomass. Potential exploitation rates could be determined from published

estimates of biological characteristics. The reviewer suggested that assessments could be conducted on small areas and extrapolated to larger areas, and that refuge areas could serve as a buffer against overexploitation. Finally, a plan to eliminate the use of bleach in fishing practices was recommended.

Reviewer 3 felt that the paper was well done. He recommends some editorial corrections and suggested an additional reference, but notes that the modelling is limited to catch, effort and surplus production.

Subcommittee Discussion

The Subcommittee acknowledged the good job of collaborative work done by the authors in preparing and presenting this paper. The Subcommittee concurred with the view the three reviewers that a stock assessment program was necessary. It was agreed that a habitat-based stock assessment could be evaluated for octopus. The Subcommittee supports that a description of the data and information needs for a choice of management approaches, including size/sex/season or quota-based, would enhance the usefulness of this phase-0 paper. The Subcommittee notes the current octopus trap fishery primarily occurs as a bycatch in other crustacean trap fisheries and that no evaluation can be made of the bycatch of octopus.

The Subcommittee noted that the Japanese octopus fishery might provide an indication of potential production in B.C., considering that it has sustained landings several orders of magnitude greater than B.C. It was suggested that data prior to 1990 on the Japanese fishery could be obtained from the Canadian embassy in Japan or through PICES.

The Subcommittee appreciated the usefulness of having specific management suggestions but felt that these would be more appropriate in the discussion section rather than as direct recommendations from the paper. The recommendations with regard to management should state simply that effort should be limited and not include allocation decisions.

Subcommittee Recommendations

The Subcommittee accepted the paper subject to minor editorial revisions and endorses the following recommendations.

1. The Subcommittee recommends that, if the directed octopus dive fishery is to be expanded, an assessment program for octopus is required and the fishery should be guided by the Framework for Providing Scientific Advice for the Management of New and Developing Invertebrate Fisheries (Perry 1996, Appendix 6).
2. The Subcommittee observes that the current octopus trap fishery is not limited and primarily occurs as a bycatch in other trap fisheries. The Subcommittee recommends that, if a directed octopus trap fishery is developed, the fishery should

be guided by Framework for Providing Scientific Advice for the Management of New and Developing Invertebrate Fisheries (Perry 1996, Appendix 6).

I98-3 Review of the biology and fisheries of Horse clams (*Tresus capax* and *Tresus nuttallii*). R. B. Lauzier, CM. Hand, A. Campbell and S. Heizer. **Accepted subject to revision**

Summary

A review of the biology and distribution of Horse clams (*Tresus capax* and *Tresus nuttallii*) and a review of the fisheries of Horse clams from British Columbia, Washington and Oregon is presented, based on previous surveys, scientific literature, and technical reports. Stock assessment strategies and possible management strategies are presented. Suggested interim management strategies appropriate for Horse clams include; continued licence limitation, a limited expansion of exploratory fishing areas, catch ceilings, time and area closures, continued rotational harvesting, and permanently closed areas to monitor regime shifts and protect broodstock. Concern was identified for the impact of harvest activities in environmentally sensitive areas, particularly eelgrass beds, as horse clams are known to co-occur with eelgrass.

Information gaps identified though this review include; horse clam recruitment mechanisms, the distribution of horse clam stocks; and estimates of biomass. Because only a minor amount of horse clam harvest has occurred to date in a limited number of geoduck beds, the true extent of horse clam biomass in B.C. is not known. The next steps in the development of a horse clam fishery would include:

- produce yield estimates based on what is known about natural mortality, longevity, growth and assumptions of recruitment;
- conduct surveys of horse clam populations to determine their distribution and density; and,
- design exploratory fisheries to determine distribution of horse clam populations.

Reviewers' Comments

Reviewer 1 thought the paper was fine review of horse clams that contained all relevant data. He thought the purpose of the working paper was concisely stated, but should be presented in the beginning of the paper. He suggested that the authors could recommend a particular yield model to be used and that it was appropriate for the authors to provide suggestions on the form that surveys might take and how the stock-recruit relationship might be estimated. The reviewer noted that the advice given in the paper reflected the uncertainty in the data. He felt that the effect of fishing on subsequent recruitment should be investigated potentially through the use of experimental study plots. Reviewer 1 wondered about the effect of compressed water jet harvesting on subsequent recruitment. The reviewer suggested including a definition of "mean mortality rates" and the problems associated with estimating M from

age-frequency in the working paper. Also, the reviewer felt that it should be made clear that the two species of *Tresus* and the presence of undersized animals cannot be reliably identified within the substrate. Reviewer 1 noted that a figure of the growth data presented in Table 1 would greatly assist the reader in understanding and visualizing the information.

Reviewer 2 felt this was an excellent start on a Phase 0 for horse clams. However, Reviewer 2 felt that there is still a significant backlog of data on horse clams that should be processed and that part of the Phase 0 should be the application of the geoduck yield models using the horse clam data. He felt that the concern regarding the disturbance of eelgrass and other vegetation by harvesting activities (anchoring, harvesting, etc.) needed stronger emphasis and that the references for the vegetation inventories should be included. Reviewer 2 noted that fishery data (CPUE, etc.) from logbooks for directed horse clams fishing was not presented and that this data should be reviewed and analyzed.

Subcommittee Discussion

The general consensus of the Subcommittee was that the paper was well written and a substantial amount of information was presented. The Subcommittee noted that geoduck surveys may not be a good representation of horse clam distributions because the surveys are not designed to survey horse clams.

It was stated that for horse clam estimates of growth, natural mortality and minimum densities are known. What are still required are the yield model work and the estimate of the variability in recruitment. The Subcommittee felt that additional work was required prior to any directed fishery on these species, as there are major data gaps including biomass estimates and yield estimates. The Subcommittee suggested that the appropriateness of critical threshold levels of assessment indices require investigation.

Subcommittee Recommendations

The Subcommittee accepted the paper subject to minor revision.

1. The Subcommittee recommends that prior to any directed fishery for horse clams the following further assessment work is required:

    - that potential yield estimates for horse clams are calculated based on what is known about natural mortality, longevity, growth and assumptions in recruitment (Subcommittee notes that this work is in progress)
    - that the use of a critical threshold level of some assessment indices is investigated; and,
    - that directed surveys of horse clam populations be initiated to determine distribution and density.

2. The Subcommittee recommends that, to obviate destruction to eelgrass and other habitat sensitive areas, harvesting or associated harvesting activities to not occur in or near eelgrass beds. A habitat assessment to determine sensitive areas is required.

3. The Subcommittee notes that opportunities for an intertidal fishery and expansion of the dive fishery exist and allocation needs to be addressed prior to commencement of a directed fishery on horse clams. Subcommittee notes that there is also a historical use of horse clams throughout the West Coast by First Nations.

I98-4 Survey of the Northern Abalone, (*Haliotis kamtschatkana*), in the Central Coast of British Columbia, May 1997. A. Campbell, I. Winther, B. Adkins, D. Brouwer and D. Miller. **Accepted subject to revisions**

Summary

Northern or "Pinto" Abalone, *Haliotis kamtschatkana*, fisheries in British Columbia (B.C.) have been closed since 1990 due to conservation concerns. Surveys are conducted every 4-5 years in different areas to monitor abalone stock status. This paper presents the results of a survey in the central coast of B. C. conducted during May 1997. A standard 16-quadrant sample method was used to compare 1997 abalone densities at index sites previously surveyed during 1979-80, 1989 and 1993 and for new areas sampled further south. The 1997 DFO survey of the historic index sites provided no evidence of recovery in abalone population in the northern portion of the central coast of B.C. Abalone densities measured from indicator sites continued to decline. Abundance of abalone in 1997, as indicated by mean densities at the index sites, were at about 10 % of 1979-80 levels and 30.7 - 54.0 % of 1989 levels. Total abalone density declined 43.75 % between the 1993 and 1997 survey. The percentage of index sites in which no abalone were found increased to 20.8 % in 1997 from 4.2 % in 1989 and 1993. The percentage of index sites in which no "legal" abalone were found almost doubled to 62.5 % in 1997, which was similar to the average (64.05 %) of all areas sampled in 1997. Comparison between areas, surveyed during 1997, indicated higher total exposed abalone densities in the south, such as the Simonds Group and near Stryker Island, than for other north areas. However, abalone densities in these southern areas of the central coast of B.C. were still well below those reported by Breen and Adkins (1982) in a few samples during 1980.

The density estimates from this study were similar to those from a transect survey also conducted in the Simonds Group and near Stryker Island during May, 1997, after the data was standardized to similar depth ranges.

The mean size of a sample of over 6,000 illegally harvested abalone, found in Calamity Bay during 1997, was larger than any of the wild populations surveyed in this study. This indicated that poachers had selectively harvested mostly large mature abalone, but with no regard for the "legal" size (when the fishery was open prior to 1990) since 16.6 % of the illegally harvest abalone were < 100 mm SL. Illegal size selective

harvesting of large mature abalone could severely reduce the reproductive potential of wild brood stock and hinder attempts to rehabilitate abalone populations in B.C. through the fishery closure.

Reviewers' Comments

Reviewer 1 noted that the methods appeared sound and the data adequate to address the objectives. The reviewer further commented on the importance of this time series data and that they should be continued. The reviewer suggested that the reasons for including the survey data from the Simonds and Stryker areas needed more explanation, as did the rationale for selection of the index sites in the original Breen and Adkins surveys. The goal is to provide the reader a basis from which to judge the representativeness of the surveyed sites, and whether conclusions based on these sites may be extended to the whole area. The reviewer further suggested that the Discussion section would be improved by addition of details on an abalone rebuilding plan, including conditions under which a fishery might proceed. Indicating the uncertainty in the indices presented was also recommended. Research needs for this species were also suggested, including frequency of recruitment events, minimum spawning biomass, and growth rates.

Reviewer 2 complemented the authors on a well-written and fully documented paper. In general, the conclusions were supported by the data and the analyses presented in the paper. Reviewer 2 did not expect that the survey design influenced the overall conclusions of very low abalone abundance's, and noted the close similarities in abalone densities among index sites, new random sites, and transect surveys. Reviewer 2 also raised the broader issue of recovery schedules for abalone, and the uncertainties pertaining to rebuilding time scales, target replacement levels, etc. The main concerns of Reviewer 2 were the influence of environmental versus non-environmental factors affecting abalone recovery. For example, while the authors felt that poaching would hinder recovery of Central Coast stocks, Reviewer 2 suggested that there is no direct evidence that this is the case. Reviewer 2 also recommended continued research into basic abalone biology.

Subcommittee Discussion

Subcommittee discussions focused on 4 main points: (1) rebuilding strategies for abalone; (2) environmental effects; (3) whether the surveyed sites were representative; and (4) status of abalone stocks on the Central Coast.

1. The Subcommittee noted that target conditions for resumption of harvest had been presented and discussed previously (PSARC I97-2), including the urgent need for a comprehensive abalone rebuilding strategy. The Subcommittee further noted that natural rebuilding is unlikely to occur.

2. The effect of changes in environmental conditions since the late 1970s was discussed as a possible cause of declines in abalone populations. It was felt that,

because the declines in abalone stocks world-wide have been caused by intensive fishing, that local environmental effects are not likely to be the primary cause of the declines in B.C.

3. The "representativeness" of the survey sites was discussed, and whether sites that had been marginal during the Breen and Adkins surveys in the 1970's (and therefore excluded as index sites) might now have become more favourable with higher abalone densities. It was concluded that, while some abalone may be found in several locations along the B.C. Central Coast, abalone have not been observed in large densities anywhere. This is of concern as, to date, no major source that might contribute significantly to natural rebuilding of the population has been identified. In addition, the presence of abalone is noted during all dive surveys conducted on the Central Coast for other species. Therefore, few if any, large aggregations of abalone are unlikely to remain undiscovered.

4. The Subcommittee agreed that there is no evidence for the recovery of central coast abalone populations, and that the population remains significantly below the 1989 level.

Subcommittee Recommendations

The Subcommittee accepts the paper subject to minor revisions, in particular regarding clarification of the representativeness of the index sites.

1. The Subcommittee supports that there is no evidence of rebuilding of abalone stocks, and that the trend shows continued declines in abalone abundance on the Central Coast. The Subcommittee has grave concerns for the abalone stocks, despite drastic management measures implemented in 1990.

2. The Subcommittee reiterates the recommendations from July 1997 regarding the urgent need for a comprehensive rebuilding plan for abalone. This plan should include biological factors such as measurement of the scale of larval dispersal, source of brood stock, growth and mortality rates, and genetic studies to identify distinct wild stocks.

3. The Subcommittee supports the conclusion that abalone densities in Area 7 are at the level at which harvesting was closed in 1989 in other areas of the coast surveyed. The Subcommittee recommends continuation of the complete closure of abalone coastwide, including Area 7.

4. The Subcommittee recommends acceptance of the index sites for monitoring Central Coast abalone populations, as they appear to be representative of randomly selected sites.

5. The Subcommittee continues to be concerned about illegal harvest of abalone, and recommends integrating DFO information on abalone across all sectors, in particular

including access to Conservation and Protection records to assist in determining the extent of illegal harvest.

I98-5 Potential ecological implications from the introduction of the European green crab, (*Carcinus maenas*), to British Columbia, Canada, and Washington, USA. G.S. Jamieson, E.D. Grosholz, D.A. Armstrong and R.W. Elner.

(This working paper (WP) has been published in primary literature. Subcommittee has reviewed the WP for the purposes of its applicability to B.C. fisheries assessment and management)

Summary

The potential impact of the European green crab *Carcinus maenas* (Decapoda: Portunidae) on possible prey species in British Columbia, Canada, and Washington State, USA. This crab was first observed on the west coast of North America in San Francisco Bay, CA, in 1989. In early 1997, adult green crab were found in Coos Bay, Oregon, about 300 km further north than its previous known range limit (Humbolt Bay, CA). Ocean current transport of larvae may introduce it to Canada in the near future. The green crab is a versatile predator with a preference for molluscan and crustacean prey. In the Pacific, green crab seem to thrive best in habitats protected from oceanic conditions and the Strait of Georgia/Puget Sound are expected to provide ideal habitat, as are coastal estuaries in Washington State. These are main production areas for both intertidal bivalves and Dungeness crab (*Cancer managister*) fisheries. It is expected that both bivalve and crab fisheries will be negatively impacted by the presence of green crab. Deltas in the Strait/Sound also support extensive migrating shorebird populations. Any change in densities of small invertebrates arising from green crab presence and predation may affect these migrating species, with ecological implications extending far beyond the actual potential range occurrence of green crab. The need for monitoring measures to document the impact of this exotic species on local ecosystems when it ultimately extends its range to Canada is discussed.

Reviewer's Comments

The reviewer noted that the information on impacts was limited and difficult to apply to B.C.. The reviewer remarked that in some areas, the European green crab has little effect on local fauna. In other circumstances, it has the potential for serious negative impact, particularly where commercially cultured species are prey items. Some life stages of the green crab may be prey items and might counterbalance some of the negative impacts. The reviewer suggests comparing the effect of the crab introduction in Tasmania where some environmental aspects are similar to British Columbia.

The reviewer suggests that the authors be encouraged to undertake baseline habitat studies in B.C., in areas where the crab is likely to thrive. This would be required in the documentation of impacts. The reviewer notes that the authors have not provided

details on how to undertake baseline studies: Would they be done before or after the introduction of the crab? What might the costs of these studies be?

The reviewer suggests studying the predatory characteristics of the green crab, which might help in predicting possible impacts on B.C. fauna, including shore birds. Details of proposed studies are not given in the paper.

The reviewer notes that the paper does not provide management recommendations, but focuses on the need for background information. The reviewer suggests that the authors specify the type of work needed to gain background information

Subcommittee Discussion

The Subcommittee requested further information such as what the length of the larval period might be (4-8 weeks) and the timing of larval release. The author provided that, in captive B.C. green crab, larval releases occurred in April and winter. The Subcommittee asked if the authors had identified likely habitat that might be impacted. The authors believe that vulnerable areas may include the Georgia Strait and everywhere else except exposed outer coast habitat. Green crabs may be found as deep as 20-40 m. The Subcommittee indicated that there were many older habitat inventories done which might provide some baseline information. Often these were one-time studies with no measure of variability.

Subcommittee Conclusions

Subcommittee notes that there is concern regarding the potential introduction of green crab. However, there is uncertainty if and when this may occur and that little can be done to stop the introduction or mitigate any resulting impacts. Subcommittee notes that green crab will likely impact on the valuable bivalve and Dungeness crab fisheries.

The Subcommittee supports that the following would be important in assessing and documenting the potential ecological impacts of green crab:

- baseline studies of representative sites, including the habitats of bivalves and Dungeness crab;
- investigation into and collection of previous habitat studies; and,
- establishment of monitoring sites.

I98-6 Selective harvest implications in Dungeness crab (*Cancer magister*) fisheries. G.S. Jamieson, A. Phillips and B.C. Smith.

(This working paper (WP) has been published in primary literature. Subcommittee has reviewed the WP for the purposes of its applicability to B.C. fisheries assessment and management)

Summary

Most commercial invertebrate, or shellfish, species are unique in that their hard shells facilitate selective culling of individual animals. Only captured individuals possessing desirable characteristics are retained, and animals returned to the sea seem to have little mortality. Robustness to physical handling has resulted in the establishment of fishing techniques and management regimes that often use specific size and/or sex selection criteria. Invertebrates have generally high fecundities and because refuge populations exist for many species, it is often assumed that a high exploitation rate only sexually-mature individuals has little significance for populations where only males above a specific size are harvested. General considerations include possible effects of fishing on reproduction, growth and availability of individuals in a year-class, but for Dungeness crab we focus on implications for reproduction. Evidence is presented that newly mature male Dungeness crab in intensively exploited populations have a two-year intermoult period, that few such sublegal crab seem to moult to legal size, and that most mating in the population is done by mature, sublegal crab. We suggest that the degree and nature of fishing may influence the parameters, and that if ignored, the long-term consequence may be selection for individuals that never exceed the legal size limit.

Reviewers' Comments

Reviewer 1 began by complimenting the authors on an interesting and well-written manuscript. The reviewer agreed with most of the interpreted life history of Dungeness crabs, with the exception of intense fishing as the cause of the 2-year intermoult period of sublegal crabs. The reviewer expressed his opinion that mating marks were of limited utility in determining whether or not crabs had mated. The reviewer questioned the assertion that x+3 instar crabs never moult to x+4 and asked for data supporting the assertion that sublegal males suffer higher natural mortality rates. Other comments were largely editorial.

Reviewer 2 indicated that the paper was well written. The reviewer suggested an experimental approach examining mating by sublegal crab in an unexploited population (i.e. in the presence of legal size crabs). The author requested clarification of the representativeness of pooled data used in the analyses. The reviewer commented that although the assertions presented in the paper merit consideration, the conclusions were unclear regarding the relationship of the concerns expressed to fisheries management. The reviewer presented two alternatives for the author's consideration.

Subcommittee Discussion

The Subcommittee noted that the paper has already been externally reviewed and accepted for publication prior to submission. At the Subcommittee's request, the author summarized the new information presented in the paper.

The paper states that:

1. instar Dungeness crab do not moult on an annual schedule, and that most have a 2+ year intermoult period;
2. most sub-legal x+3 instar crabs will not moult to legal size (implying higher mortality rates that other instars); and
3. that most mating in these populations is done by sublegal x+3 instar crabs, which represent the smallest (inferred to be the slowest growing) portion of that instar.

The Subcommittee discussed the results of the length-frequency analyses, in particular the width of size distributions assigned to each instar and their relation to moult increments. The issue of high mortality rates in sublegal male crabs was discussed, highlighting the contentious nature of this issue, and indicating that the proposed high mortality rates had both support and dissent in the literature. The supposition of generic selection is not supported by the Subcommittee discussion of sources of larvae to the population.

The Subcommittee accepted the observation that few x+3 crabs appear as x+4 crabs the following year. The Subcommittee acknowledged that the paper presented one possible explanation of this observation, but cautioned (as did the authors) that other explanations are plausible. The Subcommittee noted that these results may not be representative of all populations in British Columbia.

Discussions relating to implications to management of the fishery were deferred until presentation of the next paper.

I98-7 Moulting Patterns in Southern British Columbia Dungeness Crab and Implications for Fisheries. G.en S. Jamieson

(This working paper (WP) has been published in primary literature. Sub-committee has reviewed the WP for the purposes of its applicability to B.C. fisheries assessment and management)

Summary

Analysis of Dungeness crab data from Clayoquot Sound and the Fraser River Delta, British Columbia, over the past decade has suggested that many prerecruit male crab were dying before moulting to a size which would have allowed them to be caught in a commercial fishery. In part, this was because much mature, prerecruit, male crab appeared to have a two-year intermoult period. These mature, prerecruit male crab accounted for most of the matings that occurred in the population, but the cost of such behaviour may be their shorter life span. Data interpretation suggest that population size frequency analysis of Dungeness crab may be more complex than previously though, and that existing minimum legal size limits may not be optimal for either fishers or conservation of the species. All male crab in a yearclass should be given opportunity to breed at least once. Where fisheries largely remove most recently recruited male crab before the seasonal period of the most female moulting, and therefore mating,

delaying harvest of unmated males until after the female moult is advisable. Implications of alternative exploitation strategies for Dungeness crab allowing this are considered.

Reviewers' Comments

Reviewer 1 provided a favourable review of the paper presented. The reviewer pointed out that the objectives of the paper were clearly stated and the data presented was sufficient to support the conclusions of the paper, however presentation of additional detailed data may be useful. The reviewer expressed the possibility of promoting an even smaller terminal moult size if management changes were implemented to allow smaller legal size limit in the commercial fishery.

The reviewer provided additional information on the status of crab stocks in Alaska.

Reviewer 2 suggested that this paper is largely speculative and that data supporting some of the conclusions is not present. In addition, the reviewer stresses that the reduction of the current size limit to allow removal of a larger portion the X+3 instar may have serious consequences on stock reproduction.

In general the reviewer agrees that this paper is valuable in promoting re-evaluation of current management of the crab fishery, and provides useful insight into moulting behaviour. Specific concerns regarding the calculation of inter-moult natural mortality rates were raised, suggesting that in the absence of commercial harvest, rates are likely lower than those presented. Another concern expressed stemmed from the reviewer's personal experience with crabs, stating that the presence or absence of mating marks on larger crab may not be a good indicator of mating history. Male crabs larger than 155 mm NTN may not need to pack around a premoult female for weeks prior to mating, since larger males could potentially take a female from a smaller male.

The second reviewer had two addition major concerns with the discussions from the paper; first being the assumption of genetic selection through fishing pressure, the second being the theory that fisheries may be foregoing substantial potential harvest. The reviewer argues that the age of a crab entering the fishery may be a result of an environmental component, rather than genetic.

The second reviewer provided a recommendation to the Subcommittee that this PSARC paper be incorporated with the earlier paper presented by Jamieson PSARC I98-06, rather than stand on its' own.

Subcommittee Discussion

The authors have speculated that, based on data collected on crabs from Tofino, B.C., that the current regulations and fishery dynamics, impair the larger X+3 instar from the opportunity to mate. It is argued that this may have behavioural and/or genetic

responses in the population. The Author postulates three management changes to mitigate this circumstance.

1. Increasing the size limit to allow all the X+3 instar the opportunity to mate;
2. Delaying the fishery until after the female moult (mating period); and,
3. Delaying the fishery until after the female moult then lowering the size limit to allow complete exploitation of the X+3 instar.

The Subcommittee discussed the use of mating marks as indicators of breeding history and noted that there is evidence, as pointed out by the reviewer, to question the reliability. Further discussion followed on the timing of moulting in Dungeness crabs, and the potential impacts of delaying commercial fisheries until female moulting is complete.

The Subcommittee questioned the size frequency structure, noting that the mode range appeared to be too large. The Subcommittee contended that a reduction in minimum size limit, to allow greater opportunity for all crabs within a year class to mate, might increase mortality. The Subcommittee was also unable to agree with conclusions drawn from the paper that genetic selection was taking place due to the commercial fishing pressure.

The Subcommittee noted that data collected and evaluated in this working paper was obtained from only intensely fished areas along the coast, and may not represent or be applicable to the entire B.C. fishery.

The author clarified that management changes were not being recommended, but rather further investigation into the approach put forward.

Enforcement concerns were briefly discussed noting that different size limits within B.C. or between jurisdictions may make the fishery unenforceable. In addition, crab marketability in other jurisdictions may also be affected by a size limit change.

Subcommittee Conclusions

The Subcommittee concluded that data presented was not sufficient to recommend changes to the present minimum size limit of Dungeness crab, nor to the timing of the commercial fishery. Regarding the three options presented by the author, the Subcommittee advises that:

1. A reduction to the size limit may result in a reduction of reproductive potential, increased mortality to the X+2 instar, and a reduction in the commercial value of the harvested crab.
2. Delays in opening the commercial fishery until moulting requires knowledge of moulting periods throughout the coast which is not available.
3. There is concern that newly moulted crab may not participate in mating, thus eliminating any potential benefits of a delay in the fishery.

4. An increase in the minimum size limit for the commercial fishery, to allow all X+3 instar male crabs an opportunity to mate, is not advisable at this time due to a lack of understanding regarding impacts on the fishery.

The Subcommittee acknowledges the usefulness of this paper in initiating further discussion on management of the crab fishery, and in particular the three management options discussed.

I98-8 Catch composition of British Columbia shrimp trawls and preliminary estimation of bycatch with emphasis on eulachons. D. E. Hay, R. Harbo, K.E. Southey, J. R. Clarke, G. Parker, P. B. and P.B. McCarter. **Accepted subject to revisions**

Summary

An observer program was initiated in 1997 to determine the composition of catches in shrimp trawls in British Columbia. The project was intended to sample catches in relation to the fishing effort, season, area, and type of gear from both otter trawlers and beam trawlers. A specific concern about bycatch in shrimp trawl catches is the catch of eulachons (*Thaleichthys pacificus*). There are relatively few eulachon populations and many have declined sharply in recent years. This paper provides brief analyses of the relative bycatch in shrimp trawls for all species and provides a preliminary estimate of total bycatch of eulachons (tonnes) in different areas of the coast.

The estimates are preliminary because data on fishing effort (duration of fishing time and total tows made) are not yet available. As an alternative to data on effort, the catch of eulachons is related to the catch of shrimp (bootstrap estimates of the mean (and 95% confidence limits) from the *hailed* data on area-specific catches. The *hailed* data are known to be approximations for some areas and may slightly underestimate total shrimp catches (and therefore eulachon bycatch). The ratio of kilograms of eulachons to kilograms of shrimp is estimated from data collected from the observer program. Hailed catches of shrimp from the commercial fishery (estimated in kg for all main Statistical Areas) are used to estimate the total eulachon catches.

The highest bycatch was from otter trawlers in the central coast where the ratio of eulachons to shrimp was 0.209. Therefore, for every 1,000 kg of shrimp, 209 kg (95% CL = 171 to 248) of eulachons were caught. When adjusted by total (hailed) catch, an estimated 90.1 tonnes of eulachons were taken in the central coastal areas. Eulachon bycatch also was high in otter trawls off the west coast of Vancouver Island, where an estimated 42 tonnes were taken. In general, eulachon bycatch estimates were lower in other areas and negligible in the Strait of Georgia. Also, beam trawls had lower eulachon catches, although they took an estimated 6 tonnes of eulachons on the West Coast of Vancouver Island. A brief discussion of the biological implications on eulachons of these catch rates is presented in summary.

Reviewers' Comments

The first reviewer indicated that the paper did a good job of addressing its primary purpose of alerting fishery managers to a possible problem with eulachon by-catch in the shrimp trawl fishery. He identified that the second purpose for the paper was to serve as an analysis of the observer program that could be used to refine future sampling. The reviewer noted that final catch and effort data for 1997 are not yet available and suggested that further analysis would be worthwhile once this becomes available. The appendix was cited as a good example of developing a sampling program based on information from previous years, with a question about which years were chosen for reference purposes. The reviewer questioned the use of different geographic groupings to pool different gear types and suggested that gear comparisons could be improved. The reviewer professed some confusion regarding gear type information in Table 1 and the associated text. He questioned the different months referred to in the hail data and the observer data. He recommended further consideration of temporal variation in the eulachon/shrimp ratio and redevelopment of Table 5 by season. He suggested reconfiguration of Figure 2 to provide a sense of the relative sizes of B.C. eulachon populations The reviewer questioned if Columbia River eulachons or Fraser River fish could be present in the central coast as well as eulachons originating from nearer systems. Reviewer 1's major concern was the calculation of eulachon to shrimp catch rates based on arithmetic means of the tow-by-tow ratios of eulachon to shrimp catch. He suggested calculating the sums of eulachon and shrimp catch from the areas of interest and taking the ratios of these sums. He referred to Areas 124 and 125 and suggested that for specific areas this approach could lead to substantively different results. The authors were complimented for providing the raw data in the report.

Reviewer 2 commented that the manuscript provided a straightforward analysis of eulachon bycatch based on its catch, relative to shrimp which is then pro-rated relative to total hailed shrimp catches. However, he identified a technical error in the estimate of the mean ratio of eulachon to shrimp although the effect is unlikely to change the estimated total catches significantly. The reviewer recommended a table comparing hailed catches to final fish slip reported landings by month and area. The reviewer noted it was difficult to conclude that there is a significant problem with bycatch without further information on the size of eulachon stocks on the coast. He postulated that reduced catches could be a result of a redistribution of stocks associated with changing environmental conditions. He recommended reviewing available data from surveys in other coastal areas to assess the extent to which eulachon distribution collates with shrimp stock areas. The reviewer asked if there are any anecdotal reports from fishers that the availability or abundance of eulachons has changed significantly over the past 10 to 15 years, or if the CPUE of eulachons in the annual shrimp surveys has changed.

Subcommittee Discussion

The authors indicated that one gear type had been misidentified in the original analysis. Corrected tables were provided, however, there was no substantive change in the

results. The author agreed with many but not all of the reviewer's comments. The principal author agreed that the data would warrant re-analysis when catch and effort information became available for the period of the bycatch survey.

The issue of the appropriate bootstrap methodology was discussed. The authors agreed that the use of the arithmetic mean was correct, and agreed to revise the paper accordingly. However, he pointed out that the "corrected' results would be virtually identical to those presented in the paper. It was noted, however, that the alternative was unlikely to provide any significant change in overall results, although smaller geographic area analyses could change.

It was noted that the survey information from northern tows did not match spawning river locations. Concern was expressed that the report figures suggest that Queen Charlotte Sound bycatch was related to southern eulachon stocks when they could be related to Nass and Skeena stocks. The bycatch survey information is insufficient in terms of season and geographic extent. The bycatch program has not been successful in describing bycatch in all areas at all times. It focused on the grounds where the majority of the shrimp trawl landings occurred at the time of the bycatch survey. No inshore areas had been sampled from January to March when bycatch may be significant in these areas. Some additional information may be available from the annual west coast Vancouver Island shrimp swept trawl surveys. It may be possible to set up a bycatch index in Queen Charlotte Sound.

The authors were requested to provide a table comparing hail data to catch data. It was noted that the data do not permit conclusions regarding abundance of eulachons, only vulnerability and catchability. The present paper does not describe consistency in bycatch rates or discuss the representativeness of the sampling. It was suggested that the data could be revisited to identify areas and times where there did not appear to be an eulachon bycatch problem. It was noted that eulachon stocks move around and, consequently, the location of bycatch problems may change. The Subcommittee remarked that shrimp stocks were low on the west coast of Vancouver Island last year, and there was anecdotal evidence from fishers that bycatch was previously higher when shrimp trawl catches were greater.

There was some discussion about whether future bycatch assessment programs should focus on eulachons or generalize all bycatch species. It was questioned if the bycatch surveys should continue immediately or wait until industry introduces improved bycatch technological and fishing practice measures. The Subcommittee recognized the importance of continuing the program, especially as there were data gaps in time and area in 1997.

There was discussion whether 150 tonnes of bycatch is significant in terms of the overall stocks. It was noted that the paper does not present information about reported eulachon stock declines, how declines have been measured, and what may be contributing to those declines. Some Subcommittee members compared this bycatch to stock size of eulachon runs and Fraser River catch quotas and suggested the bycatch

appeared to be significant. The Subcommittee noted that the Fraser River precautionary quota is 20 tonnes and that the fishery was closed in 1997 because of concerns for the stocks. It was noted that this paper's estimates of eulachon bycatch would be extremely conservative representing a minimum estimate of coast wide eulachon bycatch. Some members were of the opinion that, in the absence of additional information about eulachon stock size coastwide, possible changes in stock distribution, and questions regarding the representativeness of the sampling, that the 150 tonne bycatch could not be put into context. The appropriate exploitation rate for eulachon was raised as a question. A conundrum was described by the principal author in that the bycatch is larger than expected based on the small number and size of known eulachon spawning populations.

Finally, the Subcommittee was unable to conclude if the reported level of eulachon bycatch represents a threat to eulachon stocks. However, the Subcommittee was unanimous that there is a need for this report's information to be tabled and brought to the attention of senior regional managers.

Subcommittee Recommendations

The Subcommittee accepted the paper subject to minor revision.

Based on the data presented in this paper, the Subcommittee is of the opinion that eulachon bycatch in the shrimp trawl fishery may have the potential to impact eulachon stocks and, therefore, is a serious concern. Accordingly the Subcommittee recommends:

1. The shrimp trawl bycatch assessment program should continue.
2. The information in this paper should be used for planning future bycatch assessment programs in this fishery.
3. That further development of the bycatch assessment program to include all species is required. The Subcommittee notes that there is a Bycatch Subcommittee of the Shrimp Trawl Sectoral Committee as a vehicle to consult with industry on further development of the bycatch assessment program.
4. DFO should work with and encourage industry to adopt technological and management measures to reduce bycatch; this should not be delayed.

I98-9 Status of harbour seals (*Phoca vitulina*) in British Columbia. P.F. Olesiuk.
Accepted subject to revisions

Summary

This document assesses population trends and abundance of harbour seals in British Columbia based on aerial surveys conducted during 1966-1996. It is estimated that abundance of harbour seals in the Strait of Georgia has increased about ten-fold from 4,000 (95% confidence interval of 3,050 to 4,950) animals when the first standardized censuses were conducted in 1973 to about 41,300 (95% confidence interval of 30,000

to 52,500) by 1996. Populations grew at a rate of about 11.9% per annum during the 1970s and 1980s, but the growth rate has since slowed to about 7.2%. These trends appear to be indicative of harbour seal populations throughout British Columbia, and probably represent the recovery of populations that had been depleted by predator control programs and especially commercial harvests prior to the species being protected in 1970. Total abundance of harbour seals in British Columbia in 1996 was estimated to be about 124,000 (95% confidence interval of 90,600 to 177,400) based on an extrapolation of the density of seals observed in surveyed areas to the entire province, and on the relative distribution of historical seal bounty kills. Recommendations are made for monitoring future population trends and for improving the precision of abundance estimates.

Reviewers' Comments

Reviewer 1 found the document well written and scientifically sound with only a few minor points that he felt should be either clarified or addressed. Firstly, he questioned whether pups should be included in population estimates, since the survival of pups is expected to be low. Including the pups may overestimate the total population. Reviewer 1 also questioned whether pups could be differentiated from other seals during surveys. There was a correction provided regarding the status of Stellar sea lion populations in that numbers are not stable or increasing throughout the entire southern part of their range (i.e. populations are stable in SE Alaska but declining in California). The reviewer pointed out that unlike status of stock reports in the US, there was no mention of fishery related mortality.

The reviewer felt that from an assessment point of view, the paper was thorough, scientifically valid and well written.

Reviewer 2 felt that the author should be commended for the considerable effort that had been expended to compile and analyze the recent data collected, to incorporate the refined correction factor used to expand observed counts, and to assess the statistical biases of this correction factor. The reviewer commented that in the introduction it is mentioned that there is a great deal of interest in the status of harbour seals and the impact on fishery resources but no such review or impact assessment is discussed. The reviewer also pointed out that in the paper, it was mentioned that knowledge of population trends is central to management, but no management options or any outline for a management plan is offered. The reviewer felt that this was particularly important with the respect to the dramatic change in the understanding of the size of the harbour seal population as is documented in this report (approx. 50% greater than estimated in 1988). The reviewer noted that it is stated in the paper that perhaps the present population exceeds historical levels (>100,000 animals) and that in light of recent escalated interest in seals and the impact on salmon stocks, this demanded some further discussion in the working paper. Specifically discussion is required with regard to the impact of seals on salmon/finfish and the development of an active management plan rather than a passive one for harbour seals. The reviewer commented on the information presented on haulout information and felt that a range of

correction factors would be more appropriate than the single value estimate of 39% presented as the latest and most accurate value. The reviewer had questions regarding the pooling of haulout data for both sexes, and for pups, for pooling seasonal data, and with respect to using similar tide cycles rather than the same tide-cycle and offered suggestions to alternatives. The reviewer also felt that a more detailed analysis of the contribution of environmental factors on haulout rates was required, with a comment that any refinement to this process of estimating haulout variation would be very beneficial. Reviewer 2 also questioned whether it was realistic to keep the proportion of total abundance constant for each subarea in years when subareas were not surveyed.

Subcommittee Discussion

The author provided additional information and clarification with regard to the reviewers' concerns. Discussion included the rationale behind including pups in surveys and corrections based on unborn pups when surveys were conducted early in the pupping season. A detailed discussion of haul-out patterns followed, with the author noting that haul-out patterns were comparable between different sex and age groups at daytime low tide in the summer when surveys are conducted.

It was pointed out that surveys needed to be conducted on a regular basis to keep track of population changes. There was some discussion as to whether it was preferable to remain in traditionally surveyed areas, or to expand to parts of the coast where survey information was not available, it being concluded that the strategy would depend on the specific nature of the question being addressed.

The Subcommittee noted that the distribution of seals appeared to follow the change in distribution of herring in recent years, although it was pointed out that the surveys occur in the summer at which time the primary component of seal diet is hake. A comment was also made that using length of shoreline with respect to numbers of seals probably did not provide a realistic estimation of density, since habitat requirements would not be uniformly distributed along the shoreline. It was suggested that further work exploring seal density with respect to available habitat would be useful.

It was noted that there were minor discrepancies in densities provided in the text and tables, and the author suspected this might be attributed to whether or not Jervis Inlet, which was surveyed infrequently, was included in the calculations. It was suggested that this point should be clarified in the revised text. With respect to the changes in distribution of seal populations, a question was posed as to the appropriateness of estimating populations in areas not surveyed based on subsequent years' data. It was pointed out that estimates considered surveys done in years previous to missed years, as well as following them, so that estimates were based on data interpolated from a time series.

With respect to the lack of fishery-related mortality information, it was suggested that data was available from holders of culling permits such as fish farm operators and

gillnet test fishing vessels but the reliability of this data was questioned. It was pointed out that these numbers were relatively small in comparison to the total population, somewhere in the order of 500 per annum. It was felt that it would be useful to point out that additional sources of mortality were present and these sources should be included in the paper.

There was a detailed discussion of variability in estimates of populations. The author felt that there were 3 sources of variation; the inherent variability of replicate counts, variability in the haul-out response curves, and variability in the distribution of seals or historic seal kills. The first two sources on variability were estimated from census and time-depth recorder data, but the third source cannot be evaluated until other areas have been surveyed. Missed sites in some years might introduce a slight bias, but likely not a source of statistical imprecision.

The Subcommittee requests clarification to the paper in support of reviewers' comments. Specifically, a clarification of why pups are included in the population estimates and hence represent the seasonal maximum population size and the slight discrepancies in density estimates in the text and tables need to be corrected.

Subcommittee Recommendations

The Subcommittee accepted the paper subject to minor revisions.

1. The Subcommittee recognizes that there is a lack of survey information in some areas of the coast and, if an accurate estimate of the total seal population is important, then the areas surveyed would need to be expanded.
2. The Subcommittee notes the extensive data that has been collected and supports continuation, emphasizing the value of information in the form of a historical time series.
3. The Subcommittee recommends further analysis and publication of data for external review, especially with regard to correction factors used in population estimation, since this has been the focus of reviewer and Subcommittee discussions.
4. The Subcommittee proposes that the next phase would be the development of a stock status report based on this paper, upon acceptance of this paper.

4. Fishery Updates

Fishery Updates are prepared annually by Fishery Management staff in consultation with C&P and StAD. Fishery updates are summaries of commercial fishery performance, including significant management, enforcement and stock assessment activities during the preceding year. The Invertebrate Subcommittee uses Fishery Updates to identify and discuss significant assessment and conservation issues in each fishery, and especially those for which no Working Paper was presented.

The Subcommittee notes the considerable effort to improve the format and content of the Fishery Updates, in particular the addition of a history of management actions for

the fishery and details of management and consultation of the current year. The following are issues or concerns the Subcommittee wishes to highlight from the Fisheries Updates.

Red Sea Urchin

The Red Sea Urchin fishery has 102 limited licenses and is managed by area quotas and a size limit. In addition, individual quotas are allocated and monitored through dockside validation. Industry has requested that the size limit is lowered to meet market preferences. Biological information in this fishery is limited and North Coast quotas are largely arbitrary.

A request for a working paper on yield recommendations is required by April to develop the management plan for June. Concern has also been expressed regarding the impacts on urchin stocks as a result of the increasing sea otter populations in the central coast and on the west coast of Vancouver Island.

Prawn by Trap

The Prawn by Trap fishery is limited to 257 licenses and managed by monitoring the spawner escapement (spawner index) inseason and closing areas at the appropriate spawner index. In 1995, trap limitation was implemented to control escalating trap effort in the fishery. An industry funded spawner index and trap limit monitoring program was also initiated at that time.

There is concern by both managers and fishers that industry is capable of over-fishing the stock in spite of improved inseason management and have limited confidence in the spawner index to be effective in the face of increasing effort and changing fishing patterns. The North Coast prawn stocks were unexpectedly weak in 1997 and the reasons for this warrant consideration.

There was discussion by the Subcommittee regarding a directed humpback shrimp fishery and the need for a Phase 0 for this species. Fishers are looking for alternative fishing opportunities once the prawn fishery has closed for the season.

Goose Barnacle

Goose Barnacle is a species where value of live product is high in some European markets. About 10% of the licenses issued are reporting catch and the Subcommittee notes that there may be considerable unreported catch in this fishery. The fishery is currently unlimited with no management controls. However, there are repeated requests for the approval of a dive fishery, which indicates continuing interest in the expansion in the harvest of this species. There have also been requests by some First Nations to manage goose barnacles as part of their inter-tidal clam fisheries. The Subcommittee notes that this fishery is highly dependent on markets and in 1997 a large quantity of goose barnacles was discarded as a result of dropping markets.

The Subcommittee reiterates its recommendation from July 1997 that license limitation be imposed on this fishery and that DFO explore mechanisms for improving information on actual harvest levels.

Shrimp Trawl

The Shrimp Trawl fishery is limited to 249 licenses. In 1997, extensive changes to the management of the fishery were implemented as a result of PSARC concern and advice for shrimp stocks due to the escalation of catch and effort in this fishery and recognizing that little is know about the abundance of most B.C. shrimp stocks. Area catch ceilings (precautionary and arbitrary in many cases) and a management program to track landings and monitor by-catch were established. The Subcommittee recognizes that these programs have only been in place for 9 months and that any evaluation is preliminary. The Subcommittee recommends that the precautionary approach adopted for this fishery in 1997, including the establishment of catch ceilings is continued.

As stated in I98-8, the Subcommittee has recommended a further evaluation of the by catch data and review of the by-catch program. This will also include evaluation of industry or management measures that are made to mitigate by-catch.

DFO and industry completed a joint survey and assessment of the Area 12 stocks in 1997. Survey protocols and a framework for continuation of biomass surveys is requested.

The Subcommittee complements the authors on the extensive documentation of the landmark changes in the management of this fishery.

Euphausiid

The trawl fishery for euphausiids was limited in 1993 and has 18 eligible licenses. Most euphausiid commercially harvested are frozen for use in the manufacture of fish food. An industry funded hail and validation program began in 1997 to improve the accuracy and consistency of catch and effort data. There continues to be pressure from industry to expand fishing areas and increase quotas. It was noted that there has been a re-centralizing of the catch to Malaspina Strait from quotas allocated to individual inlets.

The Subcommittee noted that new information shows a decrease in euphausiid stocks on the West Coast of Vancouver Island, however these data were not available for review. It was suggested that current euphausiid surveys of Jervis Inlet suggest that the current harvest levels are extremely conservative, again, no information was presented to PSARC. The Subcommittee noted that the current policy for euphausiid is no expansion as euphausiids are a forage species and the collateral effects on higher trophic levels are unknown. Industry would like to pursue providing evidence in support

of expansion. The Subcommittee request confirmation of the current policy for the euphausiid fishery.

Dungeness Crab

The Dungeness crab fishery has 220 licenses in seven separate areas. Beginning in 1997, a three-year pilot restricting the changing of licence areas was initiated. The fishery is managed through size, sex, season restrictions to ensure conservation and gear restrictions designed to minimize mortality. There are softshell closures in the Fraser River and Queen Charlottes. Industry has supported softshell sampling to better determine the timing of the softshell period in Queen Charlottes. Priority issues arising from the Fishery Update include a continued lack and fraudulent reporting of catch. As noted in WP 98-1 this problem limits the assessment of crab. Specific recommendations regarding the crab fishery are made as part of the WP recommendations and general Subcommittee Recommendations.

Appendix 1 Participants at Invertebrate Subcommittee Meeting July 7-10, 1997.

NAME	AFFILIATION
B. Adkins	Pacific Region Shellfish Coordinator
J. Bond	Stock Assessment Division (StAD), PBS
J. Boutillier	Head, Shellfish Section, StAD, PBS
A. Campbell	StAD, PBS
G. Gillespie	StAD, PBS
C. Hand	StAD, PBS
W. Heath	B.C. Ministry Agriculture, Fisheries & Food
S. Heizer	Fisheries Management (FM), SCD
G. Jamieson	Habitat Science
M. Joyce (Chair)	Fisheries Management, Groundfish
M. Kattilakoski	FM, SCD
B. Koke	FM, SCD
R. Lauzier	StAD, PBS
J. Lessard	Habitat Science
K. Marcus	FM, SCD
J. Morrison	FM, SCD
G. Parker	FM, SCD
I. Perry	StAD, PBS
A. Phillips	StAD, PBS
K. Southey	FM, SCD
K. West	FM, FRD
Observers:	
M. Stocker	Chair, PSARC
L. Richards	Head, StAD

Appendix 2: Reviewers of Working Papers.

NAME	AFFILIATION
B. Bechtol	Alaska Fish & Game
W. Bradbury	Washington Fish and Wildlife
S. Cox-Rogers	StAD, Prince Rupert
R. Harbo	FM, SCD
B. Hartwick	Simon Fraser University, B.C..
K. Imamura	Alaska Fish & Game
D. Jackson	Alaska Fish & Game
D. Kiezer	Aquaculture, PBS, Nanaimo
R. Kronlund	StAD, PBS, Nanaimo
G. Kruse	Alaska Fish & Game
D. Nagtegaal	StAD, PBS, Nanaimo
I. Perry	StAD, PBS, Nanaimo
A. Phillips	StAD, PBS, Nanaimo
M. Saunders	StAD, PBS, Nanaimo
J. Schweigert	StAD, PBS, Nanaimo
T. Shirley	University of Alaska Fairbanks
D. Withrow	National Marine Mammal Laboratory, Alaska
D. Woodby	Alaska Fish & Game

Appendix 3: Invertebrate landings in British Columbia, 1981 to 1996.

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995*	1996
INTERTIDAL CLAMS - Commercial Fishery:																
Razor	30	68	31	100	90	142	142	155	117	114	117	55	44	105	140	76
Butter	120	103	77	130	251	158	68	134	92	109	42	132	102	174	101	99
Manila[1]	317	597	1048	1677	1913	1893	3607	3909	2764	1456	982	914	1059	1376	1292	1041
Nat. Ln.	179	241	324	294	191	284	373	290	433	465	201	116	131	94	140	72
Mixed	161	155	279	410	477	371	87	27	159	339	137	124	133	87	3	2
SubTotal: Commercial Fishery	807	1164	1759	2611	2922	2848	4277	4515	3565	2483	1479	1341	1469	1836	1676	1290
FARMED CLAMS					4	7	25	30	31	39	169	300	300	500	885	1000
TOTAL INTERTIDAL CLAMS	**807**	**1164**	**1759**	**2611**	**2926**	**2855**	**4302**	**4545**	**3596**	**2522**	**1648**	**1641**	**1769**	**2336**	**2561**	**2290**
GEODUCK	2704	3135	2636	3483	5370	5006	5734	4567	3985	3956	3333	2864	2455	2235	**2061**	**1841**
HORSE CLAM	51	321	21	7	6	96	355	325	115	124	110	2	23	62	1	
SHRIMP	581	413	411	408	678	768	2644	2561	2299	1940	3265	2683	3283	3192	6780	7436
PRAWN	358	274	331	505	514	550	620	720	820	761	961	1168	1215	1309	1300	1710
CRAB [3]	1317	1003	960	1155	1165	1321	1631	1508	1522	2168	1887	3355	6306	6002	4594	4942
ABALONE	85	82	56	58	42	52	49	49	49	50	N/A	N/A	N/A	N/A	N/A	
OCTOPUS		18	30	25	32	53	129	209	217	198	131	117	145	72	74	130
SEA URCHIN	116	160	986	1764	1815	2067	2223									
RED								2116	2658	3158	6945	12018	6388	5829	**6255**	**6272**

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995*	1996
GREEN [4]								444	609	475	607	1042	714	332	*87*	*142.8*
SEA CUCUMBER[2]				113	346	786	1722	1922	1144	870	1340	1242	812	556	**588**	**350**
SCALLOP		8	11	18	53	68	66	67	75	69	82	91	90	104	93	100
PLANKTON	19		47	103	131	166	130	247	360	530	450	380	53	333	579	507
SQUID		29	15	69	111	79	86	88	70	72	116	93	13	175	78	71
MUSSELS			tr	1	tr	2	2	3	4	1	tr	0	0	0	0	0
GOOSENECK BARNACLES					tr	2	32	49	30	37	40	38	30	19	7	12
OYSTERS - Farmed		1579	2453	2897	3420	2864	3482	3702	3721	4547	4482	4500	4000	4900	5300	5700
TOTAL TONNES	**6038**	**8186**	**9716**	**13217**	**16609**	**16735**	**23207**	**23122**	**21274**	**21478**	**25397**	**31234**	**27296**	**27456**	**30358**	**31504**

* preliminary landings for 1995 and 1996

[1] the sum of commercial fishery landings, depurated and Aboriginal licensed harvest, and not including production from clam tenures

[2] landings are round weight

[3] crab landings include Tanner, king, other and Dungeness crabs (1989 to 1996)

[4] green sea urchin landings in 1995/96 taken from validation logs

Appendix 4 Landed value of invertebrates in thousands of Canadian dollars in British Columbia, 1981-1996

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995*	1996*
INTERTIDAL CLAMS - Commercial Fishery:																
Razor	24	55	24	123	95	127	126	137	124	130	129	82	67	186	247	135
Butter	42	36	33	55	138	75	40	63	44	53	34	81	60	103	71	70
Manila	323	611	1043	1813	2278	2762	6003	7175	6003	3761	2574	2253	2761	3776	4158	3628
Nat. Ln.	195	263	329	311	202	327	474	359	588	710	327	193	212	147	241	129
Mixed	175	169	293	455	575	510	132	36	196	625	238	252	271	198	7	6
SubTotal: Commercial Fishery:	759	1134	1722	2757	3288	3801	6775	7770	6955	5279	3302	2861	3371	4410	4724	3968
Farmed Clams:					4	14	43	59	96	140	556	1000	1200	1900	3885	4750
TOTAL INTERTIDAL CLAMS	**759**	**1134**	**1722**	**2757**	**3292**	**3815**	**59**	**7829**	**7051**	**5419**	**3858**	**3861**	**4571**	**6310**	**8609**	**8718**
GEODUCK	2434	2814	1818	2937	4605	4294	6184	9762	12967	10582	9659	16237	26994	33426	42518	36175
HORSE CLAM	42	235	12	5	6	63	309	300	144	274	119	2	46	111	2	0
SHRIMP	912	644	1073	1022	1180	1240	4609	2802	2985	2637	4430	2831	3494	4772	13796	11644
PRAWN	2019	1545	2138	3262	3379	3734	4326	5724	7083	7006	7728	8380	10121	12133	17752	26076
CRAB	3556	2345	3320	4558	4719	5661	6452	5945	6088	9311	8688	11203	18761	25686	23562	23395
ABALONE	721	696	462	530	442	734	973	1076	1170	1347	N/A	N/A	N/A	N/A	N/A	N/A
OCTOPUS		39	63	56	82	136	381	651	707	657	415	350	447	231	269	467
SEA URCHIN	34	56	358	712	763	1011	1276									
RED								1241	1631	1953	4187	8660	5271	8038	11269	12199
GREEN								584	1020	948	1795	4424	3777	2122	648	921
SEA CUCUMBER				22	94	236	768	961	998	1168	1029	1363	982	1035	947	647

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995*	1996*
SCALLOP		17	24	56	95	212	244	285	316	317	387	420	423	490	465	493
PLANKTON	6	0	19	42	89	113	102	192	223	415	390	318	41	259	369	472
SQUID		22	21	84	184	127	132	113	94	81	148	135	17	199	97	87
MUSSELS		tr	tr	tr	0	tr	tr	tr	tr	1	tr	0	0	0	0	0
GOOSENECK BARNACLES					1	4	211	479	343	413	418	448	320	181	71	112
OYSTERS - Farmed		981	1554	2109	2613	2515	2548	2725	2938	3613	3465	3600	4700	4500	5500	6000
TOTAL VALUE ($000)	**10483**	**10528**	**12584**	**18152**	**21544**	**23895**	**28574**	**40669**	**45758**	**46142**	**46716**	**62232**	**79965**	**99493**	**125874**	**127406**

*preliminary values for 1995 and 1996

[1] the sum of commercial fishery values, estimated depurated and Aboriginal licensed harvest value, and not including production from clam tenures

[2] landings include tanner, king, other and Dungeness crabs (1989 to 1996)

[3] value estimated from sales slips for 1995/96

Appendix 5 Management framework for invertebrate fisheries, 1997.

SPECIES	LICENSES	QUOTA	SEASONS	COMMENTS
Geoduck	Limited entry, 55 'G' licenses with equal I.Q.'s, divided into 3 license areas . Vessels may have up to 3 tabs. License conditions include industry funded fishing notification, catch validation and catch reporting.	1997 quota reduced to 1799.5 t for I.Q.'s of 32.7 t . plus 3.3 t for biological samples	Varies by area - with market and psp concerns. Primarily live market with highest demand in Dec/Jan. Harvest for processing in psp closed areas requires a permit and decontamination plan - none issued to date	Fishery areas are in a three year rotation. Quotas calculated based on an annual yield of 1% of virgin biomass. Harvest log and validation log combined in one form since 1995, funded by license holders.
Horse Clam	Limited to geoduck licenses only (55)	A non-directed incidental fishery with catch ceilings set by area.	Open concurrent with geoduck fishery to allow incidental catch of horse clams	Concerns about harvest practices disrupting eelgrass and unknown horse clam biomass limit fishery development.
Green Sea Urchin	Limited entry - 49 'ZA' licenses. Equal I.Q.'s and licenses transferable since 1995. License conditions include industry funded fishing notification, catch validation and catch reporting.	South coast quota 166 t. with equal I.Q.'s of 3.38 t per license North coast - with exploratory protocol on request.	License year June 1/96 to May 31/97. Fishery open mid Nov through the end of Jan in 1996/97.	Market peak in Dec/Jan. Minimum size limit in effect Considered a data-limited fishery. Previously unharvested areas to be fished with exploratory protocol.
Red Sea Urchin	Limited entry - 105 'ZC' licenses plus 4 'F' (Aboriginal). Two license areas. Equal I.Q.'s. License conditions include industry funded fishing notification, catch validation and catch reporting.	1.5 year 1997/98 quota set at 9851.4 t or I.Q.'s of 89.5 t per license, form Jan 1/97 to June 30/98.	Openings scheduled to accommodate year round market supply in the north, scheduled at request in the south, usually through peak markets of fall and winter	License year end change to be effected July 1/98 to June 30/99.
Sea Cucumber	Limited entry - 85 'ZD' licenses eligible in 1996.	1996 I.Q.'s set at 6049 lb. (2.75 t) per license,	Opened Oct 7, 1996, for 2 weeks in all areas.	Four license areas in 1996 - Queen Charlottes closed, however expected to

SPECIES	LICENSES	QUOTA	SEASONS	COMMENTS
	Area Licensing. Equal I.Q.'s. Maximum 3 licenses per vessel. License conditions include industry funded fishing notification, catch validation and catch reporting.	4 license areas - total coastwide quota unchanged at 233 t split weight.		re-open in 1997 with five license areas. Data-limited fishery. Science recommendations for non-rotational fishing areas, with large permanent closures and experimental fishery areas.
Goose Barnacle	Non-limited 'Z6' license - 56 issued in 1996	none	all year	Less than 10% of the stock estimated to be available for harvest due to harvest conditions or market quality demands
Pink and Spiny Scallop (trawl)	Non-limited 'ZR' license issued to 40 vessels in 1996	none - limited by minimum size limit	all year except for psp and permanent closure areas	limited by market, must land at a registered shellfish plant, industry participation in PSP monitoring program in 1996 and 1997.
Pink and Spiny Scallop (dive gear)	Non-limited 'ZI' license issued to 39 vessels in 1996	none - limited by minimum size limit	all year except for psp and permanent closure areas	limited by market, must land at a registered shellfish plant, industry participation in PSP monitoring program in 1996 and 1997 at key dive sites
Plankton-Euphausiids	Limited entry - 18 'ZF' licenses issued in 1996. Industry funded notification and catch validation implemented by license condition in 1997.	500 t total - 275 t in mainland inlets and 215 t strait of Georgia	Inlets open Jan to Mar, Aug to Oct. or until area quotas are landed Strait of Georgia Nov 1 to Dec 31	
Octopus (by Trap)	Non-limited 'ZP' license issued to 233 vessels in 1996	none	Inshore: open April to Dec in times and areas open to prawn fishing.	Few directed octopus by trap fishers, largely landed as incidental catch in other trap fisheries. Growing interest in a food rather that a mainly bait market.
Octopus (by Dive)	Non-limited 'ZG' license issued to 64 vessels in 1996	none	Open all year with seasonal closures for spawning. Some park and reserve closures in effect	Must be vessel based harvest, Market has been limited, but a growing interest in a food rather that mainly bait market.
Prawn Shrimp (by Trap)	Limited entry, 257 'W' licenses with equal trap	Time and area closures based on a minimum	Seasonal closure January to April/May	Increased monitoring and increased effort has resulted in earlier closures.

SPECIES	LICENSES	QUOTA	SEASONS	COMMENTS
	limits, Vessels may fish either one trap allocation (300 traps) or two (450 traps). Industry funded on-grounds monitoring.	escapement of the spawner cohort. Minimum size limits, gear escapement regulations	In 1996, the fishery closed coastwide on Aug 16/96 to April 15/97	Special Management areas maintained with separate open times and increased gear restrictions.
Shrimp Trawl	Limited entry, 247 'S' licenses plus 2 'F' (Aboriginal) licenses eligible in 1996. 1997 changes include Industry funded catch and by-catch monitoring .	From an offshore only quota of 500 t up to 1996, catch ceilings implemented in many areas for 1997	Traditionally open all year except for navigational, by-catch, reserve closures. Closures in 1997 to be implemented as catch ceilings are met. No prawn retention in areas closed to prawn fishing	Increase in catches in 1995 and 1996 have led to serious conservation and By-catch concerns. As a result, there were significant changes recommended for this fishery in 1997.
Opal Squid	Non-limited 'ZE' license issued to 107 vessels in 1996	none	permanent closures in a number of areas	
Crab	Limited entry, 224 'R' licenses eligible in 1996. Area licensing.	Managed by minimum size limit, area specific trap limits, soft-shell closures, trap escapement regulations	Area closures for soft-shell, dioxins, allocations to aboriginal or sport harvest	Non-retention of females. Rot panel and escapement port requirements for traps,
Inter-tidal Clam	Non-limited 'Z2' license issued to 1906 persons in 1996. Area licensing since 1989.	Managed by minimum size limits and a set TAC at Savary Island	seasonal openings and closures with openings staggered in an attempt to maintain market supply. Allocation closures for aboriginal and recreational fisheries.	Ongoing consultation through 1996 - recommended license limitation criteria to be implemented in 1998, along with the establishment of Community Clam Management Boards and specific Aboriginal fishery opportunities. Clam depuration harvest increased.

Appendix 6 Abstract of Perry, R. I. 1996. A framework for providing scientific advice for the management of new and developing invertebrate fisheries, PSARC Working Paper I96-6.

A framework is developed for the provision of scientific advice to support the management of new and developing (i.e. data-limited) invertebrate fisheries. The framework explicit endorses the precautionary approach to fisheries management and research. Information on the abundance, distribution, and productivity of the target species is identified as the key scientific requirement for development of precautionary management strategies. Three "phases" are proposed to obtain this information:

Phase 0) "collection of existing information", consisting of a search for available formal (and anecdotal) information on the target species (and similar species) and application of a "meta-analysis";

Phase 1) "fishing for information", consisting of surveys to obtain essential information that is insufficient or lacking in the Phase (0) analysis, and which must be based on a formal, statistical sampling design; and

Phase 2) "fishing for commerce" which consists of closely monitored fishing operations to increase the information base available, to refine the results form Phase (1) activities, and to probe the stock's response to fishing.

The roles and importance of modelling, uncertainty, additional biological studies, and the establishment of no-fishing reference area are also recognized. Throughout this framework, strong interaction and collaboration among science, management, and stakeholder activities is crucial to the provision of scientific advice for precautionary fishery management.

Appendix 7 PSARC Invertebrate Subcommittee: Request for Working Paper

PSARC INVERTEBRATE SUBCOMMITTEE

Request for Working Paper

Date Submitted:

Fish Management Initiator:

Individual or group requesting advice:
(Fisheries Manager/Biologist, Science, SWG, PSARC, Industry, Other stakeholder etc.)

Proposed PSARC Presentation Date:
(outline any timing concerns for the provision of advice)

Subject of Paper (title if developed):

Lead Author(s):

Fisheries Management Author/Reviewer:

Rational for request:
(What is the issue, what will it address, importance, etc.)

Stakeholders Affected:

How Advice May Impact the Development of A Fishing Plan:

Question(s) to be addressed in the Working Paper:
(To be developed by initiator)

Objective of Working Paper:
(To be developed by FM & StAD for internal papers)